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GROUND TEMPERATURE OBSERVATIONS AT ST. IGNATIUS COLLEGE, CLEVELAND, OHIO.

By DR. LYMAN J. BRIGGS, Bureau of Soils.

In the report of the Meteorological Observatory of St. Ignatius College, Cleveland, Ohio, 1900-1901, Rev. F. L. Odenbach, S. J., publishes a series of observations on ground temperatures made at a depth of 4 feet. The observations cover a period from 1897 to 1901. The monthly and yearly mean for each year during this period is given, and the daily temperatures during the months of February, May, and August, 1900, are also published. The following excerpt from the report of the observatory gives the method of making the determinations:

The data subjoined were gathered from a thermometer placed 4 feet below the surface of the ground. Great care was taken to insulate it from solar radiation and atmospheric temperature. For this purpose a 2-inch steel pipe was sunk into the ground, the lower end reaching 4 feet below the surface. The top end projects through the bottom of, and 4 inches into, an earthenware jar. This projecting part within the jar is capped with a movable cover made of 2.5-inch steel pipe. The jar, in turn, is covered with a lid of earthenware and the whole, which stands even with the ground surface, is covered with a wooden drum. The thermometer, which rests at the bottom of the 4-foot shaft, may be pulled up by a chain after the three covers have been removed. It is encased in a wooden tube, exposing only the grading of the mercury column; while its bulb has been insulated by a mixture of asbestos and carbonate of magnesium, held around it by a perforated brass cup. With all these precautional appliances, we are certain of getting a real ground temperature. The circulation within the tube might seem to create some difficulty, but it was supposed that the warmer air toward the surface would not descend, but that it would lose its temperature where it was, by the conductivity of the steel pipe which extended downward into colder regions. The insulation of the bulb is so perfect that it may be exposed to the direct rays of the sun for almost half a minute before it shows signs of rising; it may therefore be read with leisure and without fear of its having been influenced by the temperature existing above ground. Because it is not subject to diurnal variations, it has been read at 8 a. m., seventy-fifth meridian time, daily; this being the time at which all other observations are taken.

We regret that we can not agree with Odenbach in his conclusion that his observations represent the true ground temperature at a depth of 4 feet. It will be noted that a 2-inch steel pipe extends from near the surface of the ground to a depth of 4 feet, and that the thermometer with which the observations were made was placed inside of this pipe. The bulb of the thermometer was not embeded in the soil, but was simply suspended at the base of the shaft, or with its asbestos insolation resting upon the bottom of the shaft. The temperature recorded therefore was not the temperature of the soil, but rather that of the air in the bottom of the shaft. No provision whatever was apparently made to prevent air-convection currents in the steel tube, so that the thermometer really records the temperature of the convection currents at the bottom of the shaft. During the summer months when the temperature at a depth of 4 feet is lower than the temperature nearer the surface, the error introduced from this source would probably not be great, but during the winter months when the surface stratum of soil is cooler, the cooler air in the upper portion of the tube would continually settle towards the bottom of the shaft, and the thermometer would record temperatures lower than the actual temperature of the soil at a depth of 4 feet.

Another feature leading to erroneous results is the steel tube extending from the bottom to the top of the shaft. Steel being so much better a conductor than the soil, would, during the warmer months, readily conduct the heat down from the surface stratum and so raise the temperature of the lower portion of the shaft. In winter also, the temperature of the lower part of the shaft would by this means be reduced below the true temperature of the soil at that depth.

In the opinion of the reviewer a far more satisfactory and reliable method of investigating ground temperatures at a considerable depth below the surface is to be found in some form of electrical thermometer. An insulated coil can be buried at the desired depth and allowed to remain undisturbed throughout the whole period of investigation of temperature; the presence of all heat-conducting material other than the soil is limited to the two small wires forming the terminals of the resistance coil. This method is employed in the temperature observations now being carried on at the Radcliffe Observatory,[1] Oxford, where platinum resistance thermometers of the well known Callendar and Griffiths pattern are used. Attention should also be called to the method of reducing the observations at Oxford, first employed by Thomson,[2] which gives not only the temperature but important data regarding the thermal conductivity of the soil as well. The observations are first grouped into monthly means, and harmonic expressions are then deduced which will represent the readings of each thermometer throughout the year. From each wave as observed at any pair of thermometers two determinations of the thermal conductivity of the gravel may be obtained, one from the diminution of the amplitude of the wave and the other from the retardation of phase.

UNSEASONABLE WEATHER IN THE UNITED STATES.

By Prof. E. B. GARRIOTT, Weather Bureau, dated July 31, 1902.

The cause of unseasonable weather is not demonstrable. Neither is it possible in all cases to determine which of the general atmospheric conditions that are associated with unseasonable weather partake of the nature of cause and which of effect.

It has been observed that summer periods of low temperature are associated with barometric pressure below the normal and abundant rainfall, and that summer periods of excessive heat are associated with barometric pressure about or above the normal and a marked deficiency in rainfall. It has also been observed that winter periods of excessive cold are associated with barometric pressure above the normal and little or no precipitation, and that periods of high temperature in winter are associated with barometric pressure below the normal and rain or snow. It has been observed further that the general atmospheric conditions referred to are associated with areas of high and low barometric pressure that traverse the United States. In summer the atmosphere over regions subjected to unusual cold and abnormally heavy rainfall is dominated by areas of low barometric pressure, or general storms, that follow unusual tracks for the season, and the atmosphere over regions subjected to unusual heat is undisturbed by the passage of general storms, and is dominated by an extensive and almost stationary area of high barometric pressure. In winter periods of excessive cold are experienced in connection with areas of high barometric pressure of great magnitude that advance from the British Northwest Territory, and also in connection with general storms that follow abnormal southerly paths, and periods of unusually warm weather occur in connection with a succession of general storms that pursue abnormal northerly paths.

A study of the daily meteorological charts of the Northern Hemisphere shows that the general atmospheric conditions over the United States that are associated with unseasonable weather in any part of the country are, in turn, associated with atmospheric conditions that obtain over at least a great part of the Northern Hemisphere. The international charts

[1] Proceedings Royal Society, 67, p. 218, 1900.

[2] Transactions Royal Society, Edinburg, 22, p. 409, 1861.